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Structural Changes in Metals Consumption

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An extended model of metals demand suggests that the downturn in the intensity of metals consumption during the last 15 years can be explained largely by changes in input variables, including capital and energy, rather than by changes in the structure of demand.

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For 15 years the metals market has been characterized by slow growth — in some cases, even decline — in consumption.

To test the proposition that structural changes in demand were the main cause of the slowdown, the author — drawing on U.S. data — used an extended metals demand model that recognizes energy, labor, capital, and other materials as major inputs.

The traditional model explains metal consumption in terms only of output and the prices of metal and its substitutes. It is inadequate to address the issue of structural change because it ignores other important factors of production, such as energy, which have experienced dramatic changes.

With the extended model, the null hypothesis of no structural change cannot be rejected for most metals. With the conventional model, the null hypothesis of no structural change is strongly rejected.

Results with the extended model show that the downturn can be explained mostly by changes in the input variables, particularly such nonmetal inputs as capital and energy, which are much more important cost items than metals and have undergone drastic changes over the period.

This paper is a product of the International Commodity Markets Division, International Economics Department. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Sarah Lipscomb, room S7-062, extension 33718 (25 pages with charts and tables).

I. INTRODUCTION

A prominent characteristic of the metals markets during the past 15 years has been the very slow growth, and in some cases even declines, in the consumption of metals. Explaining the causes of this slowdown, in the face of moderate economic growth, has become a topical issue. The slowdown has important implications for those developing countries that rely heavily on exports of base metals. The severity and persistence of post-1973 declines in metals consumption per unit of GDP, first systematically described by Tilton (1985), prompted the conjecture that it may have been "structural." Although this term has not been defined precisely, it nevertheless implied permanent and irreversible shifts in demand for metals, and hence a pessimistic outlook for developing countries' exports of these materials.

There has not been a serious attempt to test quantitatively whether the declines were structural in some appropriately defined sense. The purpose of this paper is to make a first attempt in that direction. It is argued here that the traditional model that explains metal consumption in terms of output and the prices of the metal and its substitutes is inadequate to address the structural change issue because it ignores other important factors of production, some of which (such as energy) have experienced dramatic changes. In this paper, we extend the traditional model to include capital, labor, energy and materials (KLEM) as the main factors of production. This extended model explains metals consumption in terms of output, capital, and the prices of energy, labor and substitute materials, as well as the price of the metal in question. This model is estimated with aggregate U.S. data. Test results indicate that the null hypothesis of no structural change in the important parameters, defined as shifts in their values, cannot be rejected for most of the metals considered when the extended model is used, while it is strongly rejected with the conventional model.

The next section reviews the broad quantitative dimensions of the post-1973 trends in metals consumption. It is followed by the derivation and specification of the demand model. The last two sections present and summarize the estimation results.

II. METALS INTENSITY OF OUTPUT

The growth rate of the market economies' consumption of non-ferrous metals slowed down sharply from 6.2% per annum during the period 1960-74 to 1.2% in the period 1974-84.[1] All base metals experienced sharp declines in consumption growth, but it was sharper for aluminum, nickel and zinc than for copper, lead and tin.

A major part of the declines in the consumption growth rates has been attributed to the slowdown in economic growth. Because of the close relationship between materials consumption and output, a great deal of attention has been

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[1] Measured by a volume index of the consumption of aluminum, copper, tin, nickel, lead and zinc, and aggregated using as weights the Bank's 1979-81 average export prices of each metal.

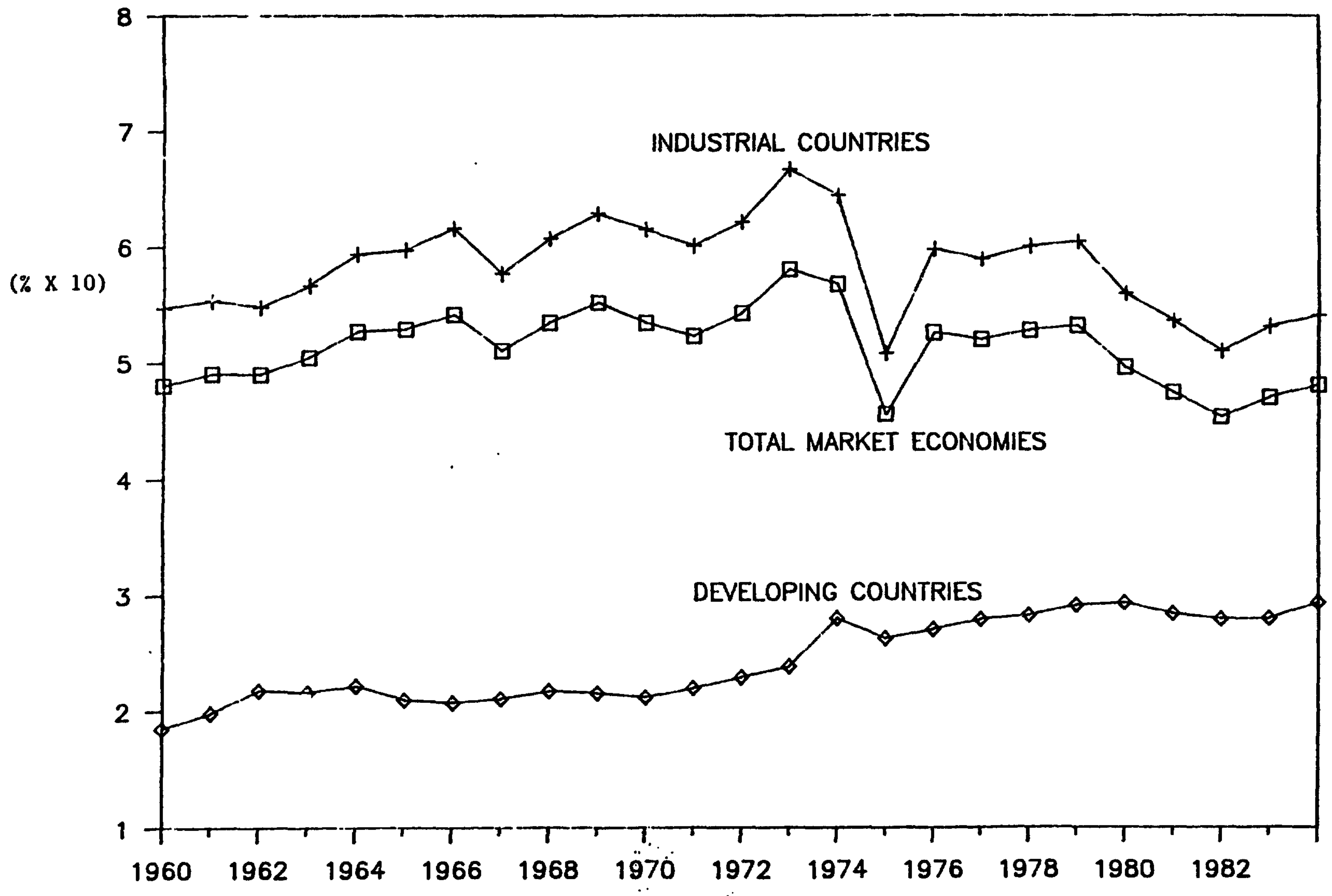
given to the intensity of its use per unit of output. The traditional explanation of the changes in intensity focussed on the shifts in the product mix of output at the aggregate level. Malenbaum (1973) postulated an inverted U-shaped relationship between metals intensity and per capita income; according to his hypothesis metals intensity is expected to increase at low levels of per capita income but decrease at higher income levels as output mix shifts from metal-intensive industries and infrastructure to services.

Chart 1 plots the changes in the metals intensity of GDP for the industrial and developing market-economy countries over the 1960-84 period.[2] Unlike previous studies that mostly dealt with U.S. data and with individual metals, the aggregation over non-ferrous metals and over the market-economy countries provides a broader perspective. In particular, it partially overcomes the statistical problems associated with international trade in metal-containing manufactured goods and substitution between metals.

It is interesting to note that during the 1960-74 period, the metals intensity of GDP experienced a mild upward trend in both the industrial and developing countries. This would suggest, contrary to general belief, that the industrial countries as a group had not reached the downward-sloping segment of Malenbaum's curve by the early 1970s. This observation is consistent with the

[2] The value of non-ferrous metals consumption (see footnote 1) at 1979-81 constant prices per US$1,000 of GDP in 1980 constant dollars.

CHART 1: METALS INTENSITY OF GDP



fact that even in the United States the share of the durable goods sector in GDP increased over this period as did the share of the service sector[3]; thus the net impact of these shifts on metals intensity could have been minimal.

Two features stand out in the post-1974 experience: the sharp decline in metals intensity during the 1975 and 1982 recessions and the subsequent failure to recover to the pre-1974 level. Even the increasing trend of metals intensity in the developing countries was substantially moderated in the early 1980s.

In Malenbaum's tradition, we can partially account for the impact of output mix changes on the intensity of use by expressing the intensity per unit of the value of industrial production (see Chart 2). Here, the declining trend after 1979-80 becomes less pronounced. Furthermore, it is only the industrial countries that experienced declines in metals intensity. This result reflects the fact that the industrial sector performed worse than the rest of the industrial and developing economies during the 1974-84 period.[4]

Analyses of metals intensity in terms of changes in output mix typically leave large unexplained residuals, particularly for the post-1974 period. This led to the conjecture, advanced by Tilton, that changes in the material

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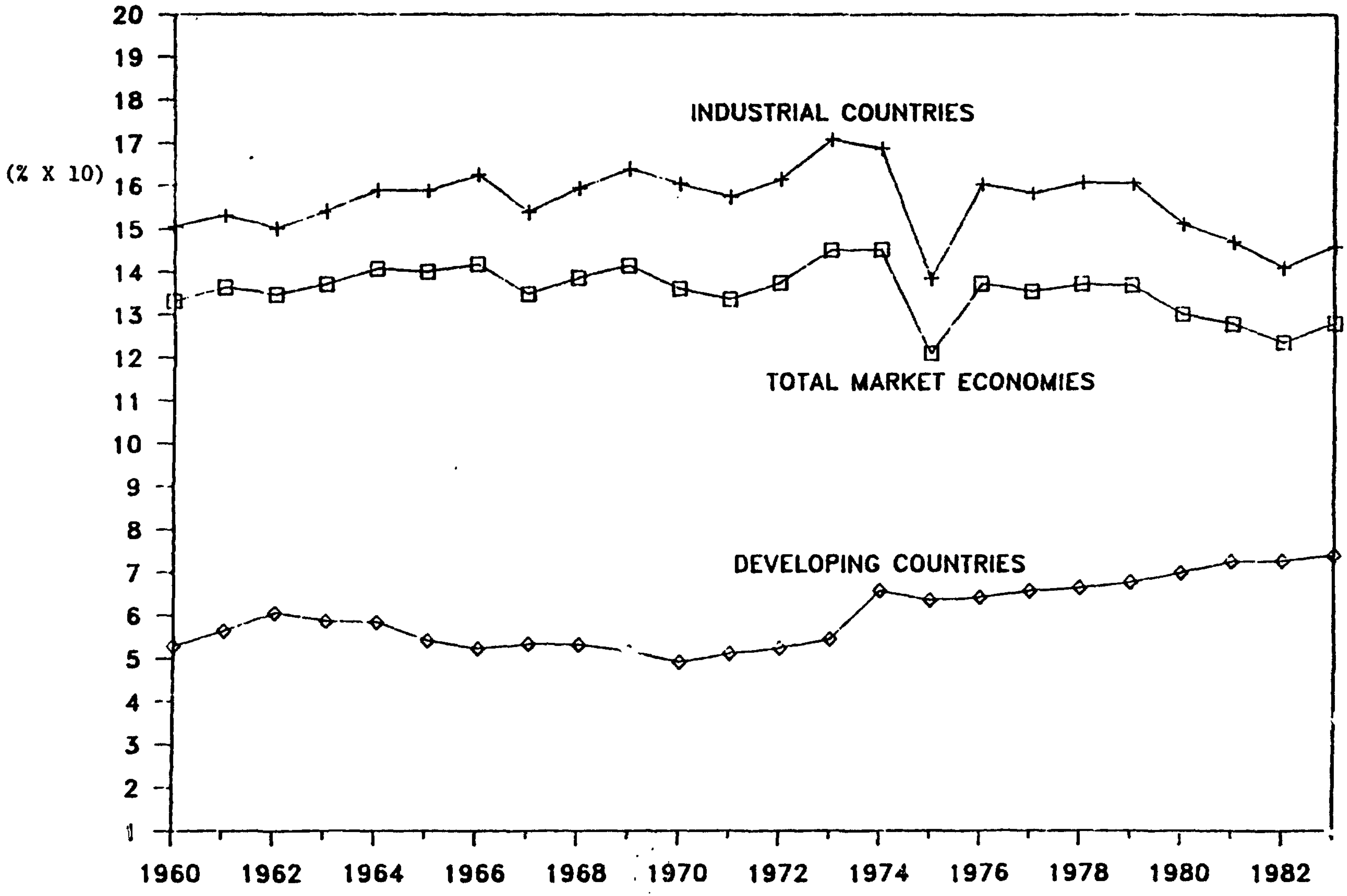
[3] The share of durable goods in U.S. GNP increased from 14.8% in 1960 to 18.4% in 1973, while that of services increased from 42.6% to 44.4% over the same period. The durable goods' share stood at 18.2% in 1980, declined to 16.6% in 1982, but regained to 19.3% in 1986.

[4] The market economies' industrial production grew faster than GDP during 1960-74 (at 5.5% and 4.9%, respectively), but at a slower rate during 1974-84 (at 1.8% and 2.9%, respectively).

CHART 2: METALS INTENSITY OF IND.PRODUCTION



composition of product, either by substitution between inputs away from the base metals or by metals-saving technological progress, may have been the main reason for the post-1974 decline in metals intensity. This assessment was based largely on industry-level individual cases where metals were displaced by other materials or simply down-sized. The aggregate importance of these changes, however, is far from clear. Furthermore, material substitution and material-saving technical progress have been going on for a long time and there may not be sufficient grounds to conclude that these changes have accelerated in the post-1974 period. Even if certain acceleration indeed took place, much of it could be interpreted as having been induced by changes in relative factor prices, particularly by high energy prices. To address the structural change issue, we need a more analytically-rich framework than the intensity-of-use analysis.

III. THE MODEL

Metals are mostly used as inputs into the production of durable goods.[5] As such, the standard economic theory on derived demand for variable factors of production applies to the demand for metals. Given the production technology (production function) and fixed stock of capital, the demand for a variable

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[5] Data on metals consumed for durable goods production are not readily available. There are, however, ample indications that metals mostly end up as components of some durable goods. In the case of copper, for example, about 50% of U.S. consumption in 1983 was for electrical equipment, 8% for transport, 20% for general engineering, 15% for construction and 7% for domestic uses. See Takeuchi, et al.(1987), p. 48.

factor such as metals can be derived from the theory of the firm's short-term profit maximizing behavior under competitive conditions.

Suppose output Q_t is produced with n variable inputs, $V_t = (v_{1t}, v_{2t}, \ldots, v_{nt})$, and one quasi-fixed input capital, K_t. Let W_t be the vector of nominal prices of V_t. The production technology can be represented by the restricted cost function, C_t, which specifies the minimum expenditure on variable factors needed to produce Q_t, given K_t:

$$C_t = C\ (W_t,\ Q_t;\ K_t,\ t). \tag{1}$$

The cost function is assumed to have the neoclassical properties. The effect of technical change on the cost of production is represented by t. By virtue of Shephard's lemma, the cost minimizing input demands are given by:

$$v_{it} = \partial C / \partial w_{it}, \qquad i = 1, 2, \ldots, n. \tag{2}$$

Suppose there are four different types of aggregate inputs -- capital, labor, energy and materials (KLEM) -- in addition to the metal(s) input in question. The materials input will be exclusive of the metal(s). Further, suppose that the cost function is quadratic. Then, the input demand equations in (2) take the following linear form:

$$MTL_t = \alpha_0 + \alpha_1 Q_t + \alpha_2 PMTL_t + \alpha_3 PSML_t$$

$$+ \alpha_4 PEN_t + \alpha_5 WGE_t + \alpha_6 K_t + \alpha_7 t, \qquad (3)$$

where MTL_t is the demand for the metal(s), $PMTL_t$ is its price, WGE_t is the labc wage rate, PEN_t is the price of energy, $PSML_t$ is the price of other materials (including substitute metals). All prices are normalized by the price of output.

The equation (3) above is the extended metals demand model to be estimated in the subsequent analysis. It differs frcm the traditional model in that it includes other input price variables (energy and labor prices) and the capital input in addition to those defining the conventional model. The latter ignores an important aspect of the post-1973 experience which has been characterized by dramatic increases in energy prices. If metals and energy are complements in the production process, a reasonable assumption, an increase in the price of energy will reduce the demand for metals. Furthermore, high energy prices have suppressed capital investment, an activity that is more metals-intensive than the rest of the economy, the effects of which are not likely to be fully captured by the chosen output variable. Thus, the conventional model can be construed as a mis-specified model and tests based on such a model will be subject to specification error.

We will define structural change as a shift in any of the parameters of the demand equation in (3). Thus, a change in the output elasticity of metals demand, presumably due to shifts in the output mix, qualifies as a structural change. Structural changes also occur if the elasticities of substitution between inputs change or the rate of metal-saving technical progress changes. This definition is different from a popular use of the term that considers replacement of metals with substitute materials as structural if the likelihood of its reversal is deemed slim. For econometric estimation, we will attach to (3) a stochastic error term, assumed to be normally distributed with zero mean and constant variance unless serial correlation is suspected.

IV. DATA AND RESULTS

Data

For the purpose of estimation, the variables in (3) pertaining to the United States are defined as follows:

Q: Index of durable manufactures production (1977=100).

K: Constant-dollar net stock of fixed private capital of durable-goods manufacturing industry (Billions of 1981 dollars).

MTL: Domestic consumption of metal(s).

PMTL: Producer price of metal(s).

WGE: Average hourly gross earnings per production worker of durable goods industries.

PEN: Producer price index for fuels and power (1977=100)

PSML: Producer price of substitute metal or producer price index for intermediate materials and components.

Metals consumption and price data are those of the World Bank; the rest are taken from various issues of the Survey of Current Business and Business Statistics, U.S. Department of Commerce. All prices and price indexes are deflated by the producer price index for durable manufactures.

Most of the variables defined above have measurement problems. Desirably, some of them should be quality-adjusted; particularly troublesome are the measures of capital and output.

Results

To test whether there have been structural shifts in any subsets of the parameters, we perform a series of equality tests (Chow tests) between the parameters for the two sub-periods 1950-73 and 1974-85. We do this test with alternative demand models -- the extended model in equation (3) and the conventional (truncated) version with the constraint that $\alpha_4 = \alpha_5 = \alpha_6 = 0$.

Before going into tests of the structural change hypothesis, it would be useful first to see if the parameters of the extended model are statistically significant. Table 1 shows test statistics for the null hypothesis that $\alpha_4 = \alpha_5 = \alpha_6 = 0$. This test is conducted under alternative maintained hypotheses that structural changes in these parameters have or have not occurred.

When structural change is assumed, it is clear that the coefficients of the energy price, wage rate and capital variables are jointly not significantly different from zero except for lead and tin. That these variables are unimportant in explaining metals consumption cannot be rejected for most metals. However, when structural change is not posited, this hypothesis is strongly rejected, except for aluminum. These results suggest the possibility that the effects of changes in these variables in the post-1974 period can be mistaken as structural changes.

We now test the null hypothesis of no structural change in subsets of the parameters. The first null hypothesis to be tested is the equality of all coefficients between the two sub-periods, i.e., $\alpha_{i,50\text{-}73} = \alpha_{i,74\text{-}85}$ for all i. Table 2 shows the test statistics. For most metals, the null hypothesis is strongly rejected regardless of the models used. It is rejected more strongly with the conventional than with the extended model. The significance of this test, however, should be weighed against the tendency that, when a large number of coefficients are involved as in this case, the test statistic usually becomes significant. Therefore, the rejection of the null hypothesis in the case of the extended model may be considered not strong enough because the test statistics

TABLE 1: TESTS OF THE EXTENDED MODEL

	ASSUMING NO STRUCTURAL CHANGE		ASSUMING STRUCTURAL CHANGE	
ALUMINUM	1.69	(3,28)	1.61	(6,20)
COPPER	10.87**	(3,27)	1.64	(6,19)
LEAD	12.55**	(3,29)	5.91**	(6,22)
NICKEL	3.24*	(3,23)	1.69	(6,16)
TIN	10.01**	(3,29)	2.92*	(6,22)
ZINC	74.99**	(3,29)	2.48	(6,22)
TOTAL METALS	32.32**	(4,28)	4.11**	(8,20)

NOTE: IN THIS AND SUBSEQUENT TABLES, THE FIGURES IN PARENTHESES SHOW THE NOMINATOR AND DENOMINATOR DEGREES OF FREEDOM OF THE F DISTRIBUTION.

* SIGNIFICANT AT 5% LEVEL.

** SIGNIFICANT AT 1% LEVEL.

SOURCE: INTERNATIONAL ECONOMICS DEPARTMENT, WORLD BANK.

TABLE 2: TESTS OF STRUCTURAL CHANGE -- ALL PARAMETERS

	CONVENTIONAL MODEL		EXTENDED MODEL	
ALUMINUM	7.86**	(5,26)	5.39**	(8,20)
COPPER	11.63**	(5,25)	3.06*	(8,19)
LEAD	15.74**	(4,28)	8.46**	(7,22)
NICKEL	9.78**	(4,22)	4.24**	(7,16)
TIN	8.58**	(4,28)	3.03*	(7,22)
ZINC	40.94**	(4,28)	0.98	(7,22)
TOTAL METALS	31.72**	(4,28)	4.01**	(8,20)

* SIGNIFICANT AT 5% LEVEL.

** SIGNIFICANT AT 1% LEVEL.

SOURCE: INTERNATIONAL ECONOMICS DEPARTMENT, WORLD BANK.

do not greatly exceed the critical F values as with the conventional model.

Let us now focus on the parameters of our interest, namely the coefficients of the output variable, the time trend, and the intercept. Significant declines in the output coefficient would indicate shifts in the output mix, presumably from metal-intensive heavy industries to light industries such as electronics. A downward shift in the time trend parameter would suggest an acceleration of the rate of metal-saving technical progress. A decline in the intercept term would indicate a one-time improvement in the efficiency of metals consumption. Structural changes in these parameters are tested individually and jointly, while the remaining coefficients are allowed to vary between the two sub-periods.

Table 3 shows the test statistics for the null hypothesis that there has been no structural change in the output coefficient. The null hypothesis of no structural change in the metal/output relationship cannot be rejected for all metals when the extended demand model is estimated. It is rejected only for aluminum and copper when the conventional model is used. In the case of aluminum, changes in the output mix have been toward more aluminum-intensive products rather than the other way around. The null hypothesis is also rejected for the total of nonferrous metals, dominated by aluminum and copper.

Overall, the evidence on structural shifts in the output mix is rather weak for both the conventional and the extended models. One can suspect that this result has a lot to do with the choice of durable manufactures production as the output variable. However, even if this is the case, we cannot conclude that

TABLE 3: TESTS OF STRUCTURAL CHANGE IN OUTPUT MIX

	CONVENTIONAL MODEL		EXTENDED MODEL	
ALUMINUM	11.47**	(1,26)	0.18	(1,20)
COPPER	4.99*	(1,25)	1.62	(1,19)
LEAD	3.70	(1,28)	3.97	(1,22)
NICKEL	0.08	(1,22)	0.58	(1,16)
TIN	1.47	(1,28)	2.37	(1,22)
ZINC	0.60	(1,28)	1.53	(1,22)
TOTAL METALS	4.70*	(1,28)	1.36	(1.20)

* SIGNIFICANT AT 5% LEVEL.

** SIGNIFICANT AT 1% LEVEL.

SOURCE: INTERNATIONAL ECONOMICS DEPARTMENT, WORLD BANK.

structural change in this coefficient has occurred because fluctuation in the share of durable manufactures in GDP or industrial production may be considered more cyclical than structural.

With the conventional model, the null hypothesis of no structural change in the rate of technical change is rejected at the 1% significance level for all the metals (see Table 4). This result appears to suggest strongly that the rate of metal-saving technical progress significantly accelerated in the 1974-85 period. However, in a manner consistent with the previous test results, the extended model results present a substantially different picture. The null hypothesis of no structural change in technical progress can be rejected for copper, lead and nickel at the 5% significance level and for tin at the 1% level. The null hypothesis cannot be rejected for the total of metals. For all the metals except tin, the test statistic is sharply reduced when the extended model is used instead of the conventional one.

Test results for the intercept present a similar picture to those of the output coefficient (see Table 5). With the extended model, it is difficult to say that the intercept has shifted downward except for copper. The conventional model yields estimates supporting one-time efficiency improvements in the post-1974 period. The only exception here is zinc.

We now test the three coefficients jointly; the null hypothesis asserts no structural change in all of the three coefficients. Test results (see Table 6) are similar to those for technical change alone. The null hypothesis cannot

TABLE 4: TESTS OF STRUCTURAL CHANGE IN THE RATE OF TECHNICAL PROGRESS

	CONVENTIONAL MODEL		EXTENDED MODEL	
ALUMINUM	24.39**	(1,26)	0.90	(1,20)
COPPER	20.03**	(1,25)	5.28*	(1,19)
LEAD	34.56**	(1,28)	6.89*	(1,22)
NICKEL	19.36**	(1,22)	7.70*	(1,16)
TIN	11.07**	(1,28)	8.06**	(1,22)
ZINC	9.78**	(1,28)	0.72	(1,22)
TOTAL METALS	35.64**	(1,28)	3.22	(1,20)

* SIGNIFICANT AT 5% LEVEL.

** SIGNIFICANT AT 1% LEVEL.

SOURCE: INTERNATIONAL ECONOMICS DEPARTMENT, WORLD BANK.

TABLE 5: TESTS OF STRUCTURAL CHANGE IN INTERCEPT

	CONVENTIONAL MODEL		EXTENDED MODEL	
ALUMINUM	12.87**	(1,26)	0.24	(1,20)
COPPER	13.81**	(1,25)	5.53*	(1,19)
LEAD	31.01**	(1,28)	1.30	(1,22)
NICKEL	10.55**	(1,22)	0.60	(1,16)
TIN	6.90*	(1,28)	2.58	(1,22)
ZINC	0.76	(1,28)	0.12	(1,22)
TOTAL METALS	9.98**	(1,28)	4.17	(1,20)

* SIGNIFICANT AT 5% LEVEL.

** SIGNIFICANT AT 1% LEVEL.

SOURCE: INTERNATIONAL ECONOMICS DEPARTMENT, WORLD BANK.

be rejected for aluminum, copper, zinc, and for total metals with the extended model, but is strongly rejected for all the metals with the conventional model.

The above test results suggest that a mis-specified model, in the sense that some relevant variables are left out, can lead to the wrong conclusion that structural changes in consumption have taken place. This would be particularly the case when the left-out variables have undergone substantial changes.

Parameters of the extended model are estimated under the assumption of no structural change and reported in Table 7. When the price variables are lagged one period to obtain better estimates, the error term is assumed to have first-order autocorrelation and the estimates are corrected for its presence. Overall, the goodness-of-fit statistics are reasonably high. The estimates of coefficients for the output, substitute materials, and wage rate variables mostly have good statistical properties. However, the coefficient estimates for own price, energy price, and capital stock tend to be statistically insignificant or have the wrong sign. The poor results for the own-price coefficient are not surprising in that metals are usually minor cost items in production and the simultaneity with supplies has not been addressed in the estimation. Much of the instability in the estimates appears to be due to multicollinearity between the variables, particularly between the wage rate, capital stock and time trend variables. When a subset of these variables are removed from estimation, the remaining coefficients tend to become statistically significant and have the correct sign, including those of the own- and energy prices.

TABLE 6: TESTS OF STRUCTURAL CHANGES IN OUTPUT MIX, TECHNICAL CHANGE AND INTERCEPT

	CONVENTIONAL MODEL		EXTENDED MODEL	
ALUMINUM	12.58**	(3,26)	0.46	(3,20)
COPPER	10.27**	(3,25)	2.77	(3,19)
LEAD	20.38**	(3,28)	3.59*	(3,22)
NICKEL	11.73**	(3,22)	4.72*	(3,16)
TIN	5.61**	(3,28)	6.08**	(3,22)
ZINC	29.92**	(3,28)	0.77	(3,22)
TOTAL METALS	25.73**	(3,28)	2.94	(3,20)

* SIGNIFICANT AT 5% LEVEL.

** SIGNIFICANT AT 1% LEVEL.

SOURCE: INTERNATIONAL ECONOMICS DEPARTMENT, WORLD BANK.

TABLE 7: ESTIMATES OF THE EXTENDED DEMAND MODEL

	ALUMINUM	COPPER A/	LEAD A/	NICKEL	TIN A/	ZINC	TOTAL METALS
α_0	1.87	-1.60	-0.57	-0.22	-0.02	-2.67	-0.97
	(0.8)	(-1.4)	(-1.0)	(-2.1)	(-0.7)	(-4.2)	(-3.6)
α_1	3.91	2.37	0.75	0.19	0.03	0.60	0.61
	(4.9)	(5.4)	(3.4)	(4.4)	(2.9)	(1.9)	(5.1)
Elasticity B/	0.96	1.06	0.48	1.12	0.44	0.41	0.67
α_2	-4.24	0.08	-0.02	-0.52	0.001	0.05	0.66
	(-2.7)	(0.3)	(-0.9)	(-0.6)	(1.3)	(1.9)	(3.9)
α_3	1.57	1.08	0.005	0.02	0.04	-0.02	0.20
	(3.8)	(1.4)	(0.2)	(3.6)	(1.8)	(-0.3)	(3.0)
α_4	-0.28	0.001	0.09	0.02	-0.004	-0.30	-0.08
	(-0.8)	(0.008)	(0.8)	(0.7)	(-1.1)	(-2.2)	(-1.6)
α_5	-0.21	0.83	0.65	0.10	0.03	1.36	0.32
	(-0.3)	(2.3)	(3.0)	(2.6)	(2.7)	(5.7)	(3.3)
α_6	-0.48	-0.43	-0.006	-0.007	-0.01	0.62	-0.13
	(-0.8)	(-1.3)	(-0.03)	(-0.3)	(-1.8)	(3.0)	(-1.6)
α_7	0.09	-0.02	-0.04	-0.007	-0.001	-0.10	0.005
	(1.6)	(-0.8)	(-1.9)	(-2.1)	(-1.6)	(-5.7)	(0.6)
$\bar{R}^2$	0.97	0.88	0.83	0.77	0.84	0.89	0.96
D-W	1.65	1.64	1.69	2.31	1.47	2.20	2.15

* SHOWN IN PARENTHESES ARE THE T-STATISTICS.

A/ WITH ALL PRICES LAGGED ONE PERIOD AND ESTIMATES CORRECTED FOR FIRST-ORDER SERIAL CORRELATION.

B/ ELASTICITY OF THE OUTPUT COEFFICIENT (α_1), EVALUATED AT THE MEANS OF THE VARIABLES.

SOURCE: INTERNATIONAL ECONOMICS DEPARTMENT, WORLD BANK.

It can be seen that the bulk of variations in metals consumption is explained by changes in durable goods production. The estimated demand elasticities with respect to durable goods range from 0.4 to 1.1. Copper, nickel and aluminum have higher output elasticities than tin, lead and zinc. Furthermore, the output elasticity does not appear to have significantly declined between the periods 1950-73 and 1974-85. The estimates generally indicate that metals are complements with energy and capital but substitutes with labor. Energy plays an important role in explaining aluminum and zinc consumption; the weak statistical significance in the case of aluminum improves dramatically when the wage rate variable is eliminated. Labor cost is a statistically significant explanatory variable for all the metals except aluminum. Capital stock has a negative coefficient for all metals except zinc, suggesting that they are substitutes in the production process.

V. CONCLUSIONS

The model developed here provides a useful framework for analyzing the structural change issue in estimating and forecasting raw materials consumption. The test results suggest that quantitative evidence on structural change in metals consumption is rather weak, as far as U.S. data are concerned. The results show that in testing this type of hypothesis, it is important to use correctly and fully specified models because specification error can be mistaken for structural change in the subset of coefficients. In the context of metals demand, non-metal inputs, such as capital and energy, could be more important explanatory variables than the own price of the metal, because of substitutability or complementarity between these inputs and metals and because metals usually constitute a relatively minor cost item compared to these inputs.

It would be of interest to obtain similar estimates for the industry subsectors and for other industrial countries. Data problems, particularly regarding measures of capital, are likely to be a major constraint, however.